CHAPTER 7

BATTLE DAMAGE REPAIR

To repair battle damage, you must have an extensive knowledge of the available damage control equipment and materials. You must know how to repair holes in the hull and use shoring. These topics are discussed in this chapter.

DAMAGE CONTROL EQUIPMENT AND MATERIALS

The equipment and materials required to make repairs to battle damage vary according to the nature of the damage. Since several types of damage can occur aboard ship, you must know how to use a wide variety of equipment and materials. The *Repair Party Manual* has several repair locker inventory lists for various types of ships. A typical repair locker will usually contain some or most of the following equipment, depending upon the ship's allowance:

- Oxygen breathing apparatus and six canisters for each OBA on the allowance
- Protective gloves (hot work, nonasbestos)
- Proximity suits
- Tending lines
- Miner's lights
- Flashlights
- Sealed-beam lights
- Battle lanterns
- Extension lights
- Sounding rods/sounding tapes
- Helmets
- Life jackets
- Hand tools
- Electrical tools
- Chain hoist and straps
- Blocks and tackle
- Screw and hydraulic jacks
- Manila line
- Forcible entry tools
- X40J cable and jack boxes
- Oxygen indicator
- Combustible gas indicator (explosimeter)
- Toxic gas detector
- Respirators
- Air-line hose masks
- Emergency-cutting outfit
- Electrical kits
- Rubber boots
- Rubber gloves
- Spare electrical cable
- Steel wedges
- Hose and pipe flanges
- Hose and pipe adaptors

- Shoring kit and shoring batten
- Plugging kit
- Pipe-patching kit (soft patches)
- Blower sleeves
- Prefabricated patches (wood and steel)
- Sound-powered phones
- Basket strainer
- Submersible pump
- Gas masks
- CBR defense protective clothing
- CBR defense detection equipment and markers
- Decontamination equipment
- Fire rakes and ladders
- Foam nozzles and extra fire hose
- In-line foam inductor

On ships that have subgroups, some of this equipment is stowed in the unit lockers. Additional damage control equipment is dispersed throughout the ship in designated areas. This equipment includes the following:

- Portable gasoline-driven fire pumps (P-250 or P-250 Mod 1) and hoses
- Fire hose
- Nozzles
- Applicators
- FP-180 water motor proportioner
- Spare AFFF cans
- CO_2 extinguishers
- Dry-chemical extinguishers
- Portable blowers
- Shallow-water diving gear
- Submersible pumps
- Eductors
- Shoring kit
- Shoring materials
- Plate patches
- Battle lanterns
- Casualty power cables

RELIABILITY OF DAMAGE CONTROL EQUIPMENT

The damage control organization cannot function without an adequate supply of damage control equipment. As a Damage Controlman, you will help to ensure that all damage control equipment is available and in good condition.

Frequent inspections are required in accordance with PMS guidelines. Those inspections ensure that all damage control equipment, tools, and materials on your ship's allowance list are actually on board. Compare the ship's allowance list with an accurate and up-to-date inventory list of onboard damage control equipment.

Check to see that all damage control equipment is stowed or installed in its designated location and that it is readily accessible. Emergencies can be handled much more effectively if the equipment is available and if you do not have to waste time looking for it.

The equipment assigned to each repair locker should be identified in such a way that each of the items can be returned to that repair locker after they have been used. A simple color code marking system can be used. All tools and equipment that belong to a certain repair locker should be marked with a striped band or a spot of that repair locker's identifying color.

Damage control equipment should NEVER be used for any purpose other than damage control. Damage control equipment is located throughout the ship, and some people are tempted to use it just because it is handy. This must NOT be allowed. All hands must realize that their lives may literally depend upon the ready availability and condition of damage control equipment in an emergency.

DAMAGE CONTROL KITS

At each repair locker a number of repair kits are made up and stowed in canvas bags. These kits are kept ready to be taken to the scene of damage. The kits should be constructed and packaged so that they will fit through the smallest watertight scuttle on your ship. These kits are commonly ailed plugging kits, pipe-patching kits, and shoring kits.

Each damage control kit should have a list of contents attached to the carrying strap. The list makes it relatively simple to inventory the contents of the kit. All damage control kits and repair locker equipment must be inventoried in accordance with PMS requirements and after each use. Any equipment or material found missing during the inventory should be replaced as soon as possible. The ship's *Repair Party Manual* and *Surface Ship Damage Control,* NWP 62-1, list the equipment that is required in the ship's repair lockers. Your ship's coordinated shipboard allowance list (COSAL) shows the amount of each item that is allowed for the ship. Extra plugging and pipe-patching kits are made up for the engineering spaces. These extra kits are inventoried and maintained by the personnel assigned to the engineering spaces. Each damage control kit should be identified by a stencil on the outside of the bag.

RIGGING GEAR

Repair lockers have various kinds of rigging gear, such as chain falls, screw or hydraulic jacks, wire hawsers, block and tackle, and manila line. This gear is useful to clear away wreckage, restore equipment to its original position, and shoring. To a limited extent, you can use rigging gear to hold equipment in position. However, do not rely upon it to do the work of shores. You can use a jack to push heavy weights back to their proper positions. You may want to use chain falls and block and tackle to pull weights back into position or to hold equipment in place while shoring. Whenever equipment is being hoisted, be sure the rigging gear is secured to a stout pad eye, beam, or strongback. If the weight is loose and free to move, check the motion with steadying lines.

PATCHING MATERIALS

A number of materials are available to plug and patch holes and to cover and secure patches. Some of the materials commonly used for these purposes are mentioned here.

Plugging and patching materials include wooden plugs and wedges, wooden shoring, prefabricated wooden box patches in various sizes, rags, pillows, mattresses, blankets, kapok life jackets, metal plate, folding metal plate patches, flexible sheet metal patches, prefabricated steel box patches, bucket patches, and welded steel patches.

Securing materials include assorted hook bolts, manila line, wire rope, chain, machine bolts, angle clips for welding, and shoring.

Backup materials include mess tables, metal joiner doors, buckets, plywood or lumber, sheet metal, and metal plate.

Gasket materials include sheet and strip rubber, leather, canvas, rags, oakum, and paint.

HOLES IN THE HULL

Any rupture, break, or hole in the ship's outer hull plating, particularly below the waterline, can allow seawater to enter the ship. If flooding continues uncontrolled, the ship will sink. When the underwater hull is pierced, there are only two possible courses of action. The first, obviously, is to plug the holes or openings. The second is to establish and maintain flooding boundaries within the ship to prevent further progress of the flooding. Dewatering can be effective only after these two measures have been taken.

There is one very important thing to remember about flooding: a ship can sink just as easily from a series of small and insignificant looking holes as it can from one large and more dramatic looking hole. The natural tendency is to attack the obvious damage first and to overlook the smaller holes in the hull and in interior bulkheads. You may waste hours trying to patch large holes in already flooded compartments. Meanwhile, you disregard the smaller holes through which progressive flooding is taking place. In many cases, it would be better to concentrate on the smaller holes. As a rule, the really large holes in the underwater hull cannot be repaired until the ship is dry-docked.

All holes in the hull, large or small, should be plugged completely as soon as possible. As an interim measure, all holes should be partially

plugged if they cannot be completely plugged. Even a partial plug can substantially reduce the amount of water entering the ship. This will substantially reduce the danger of sinking.

Holes in the hull that are at or just above the waterline should be given immediate attention. Holes in this location may not appear to be dangerous but they are. As the ship rolls or loses buoyancy, the holes become submerged and allow water to enter at a level that is dangerously high above the ship's center of gravity. These holes must be plugged at once. Give the holes at the waterline or on the low side priority (if the ship is listing), and then plug the higher holes.

The same methods and materials used to repair holes above the waterline are also used, for the most part, in the repair of underwater holes. The repair of underwater holes tends to be more difficult. Therefore, any Damage Controlman who can repair underwater damage must certainly be able to repair similar damage above the waterline. For this reason, most of the discussion in this chapter will deal with the repair of underwater damage.

FACTORS AFFECTING UNDERWATER REPAIRS

The two main factors that make it difficult to repair underwater holes are the pressure exerted by the water and the relative inaccessibility of the damage. The difficulties caused by water pressure are often exaggerated. Actually, a hole 7 feet below the waterline is only subjected to a water pressure of about 3 pounds per square inch.

Figure 7-1 shows the flooding effect of unplugged holes and of the same holes after inserting simple plugs. The volumes of flooding water are given in gallons per minute. The number of electric submersible pumps required to handle the flooding is also shown. It should be obvious that prompt plugging of holes is desirable. It can save the ship, it releases pumps for use elsewhere, and it saves wear and tear on the pumps that are in use. Note that the pump capacities used are considerably under the rated capacity, usually 180 gpm. However, if the pump strainers get clogged with debris, the actual capacities may be much less than the rated capacity.

The greatest difficulty in repairing underwater damage is usually the inaccessibility of the damage. If an inboard compartment is flooded, other compartments will flood if you open doors or hatches to get to the actual area of damage. In such a case, it is usually necessary to send a crew member wearing a shallow-water diving outfit down into the compartment. The repair work may be hampered by tangled wreckage in the water, the absence of light, and the difficulties of trying to keep buoyant repair materials submerged.

PLUGGING AND PATCHING HOLES

The procedures discussed here for plugging and patching holes are intended for emergency use. They are temporary repairs that can be done to keep the ship afloat while it is in action. In most cases, they do not call for elaborate tools or equipment. They involve principles that can be applied when using wooden plugs, prefabricated patches, or other readily available materials.

There are two general methods of making temporary repairs to holes in the hull: put something in it or put something over it. In either case, the patches will reduce the area through which water can enter the ship or through which water can pass from one compartment to another.

Plugging

The simplest method of stopping up a fairly small hole is to insert some kind of plug. Plugs made of softwood, such as yellow pine or fir, are quite effective for plugging holes up to about 3 by 3 inches in size. Sometimes you may use these plugs to plug larger holes as well.

The plugging kit consists of the following items:

- A canvas bag, with a carrying strap, approximately 30 inches deep and 12 inches in diameter
- Softwood plugs; a minimum of 10 plugs in various sizes from 1 inch to 10 inches in diameter

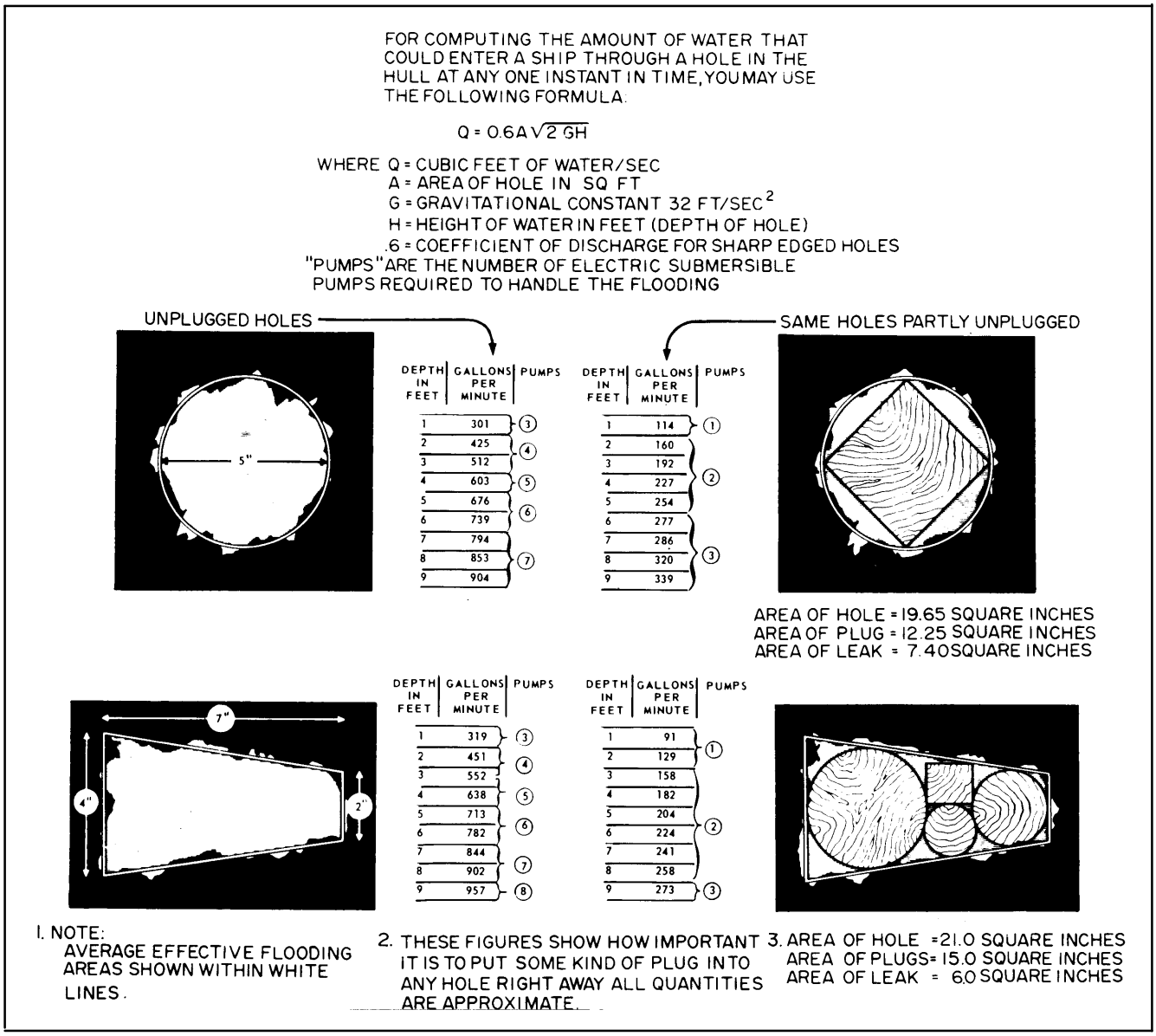

Figure 7-1.—Flooding effect comparison; unplugged holes vs. partially plugged holes.

- Five pounds of oakum or rags
- One hatchet
- One cold chisel
- Onmetal caulking iron
- Wedges made of softwood; a minimum of eight wedges, 2 inches by 4 inches and 12 inches long
- One maul or sledge
- One hammer, a minimum 2 pounds in weight
- One crosscut handsaw for cutting wood

The plugs and wedges may be used individually if they fit the hole. Often, however,

it is best to use a combination of conical, square-ended, and wedge-shaped plugs to make a better fit in the hole. One such combination of plugs is shown in figure 7-2.

It is best to wrap each plug with lightweight cloth before inserting it. The cloth tends to keep the plugs in place and fills in some of the gaps between the plugs. In most cases, plugs will not make a watertight fit. However, you can substantially reduce the rate of leakage by using the plugs and then caulking the remaining leaks with rags, oakum, and smaller wedges. Square-ended plugs tend to hold better than conical plugs in holes located in plating that is one-fourth of an inch or less in thickness.

Most wooden plugs are inserted from the inside of the ship. When plugging a hole in this manner, you must contend with the metal edges that are protruding inward. You normally will not have this problem when plugging a hole from the outside of the ship. However, plugs on the outside of the ship cannot be tended easily nor will they hold very well over an extended period of time. If it is necessary to insert the plugs from the outside of the hull, fit the inboard ends of the plugs with screw eyes. A line running from each screw eye and secured to a solid structural member inside the ship will help to keep the plug in place.

Patching

Box patches are effective for use over holes that have jagged edges projecting inboard. View A of figure 7-3 shows a typical metal box patch;

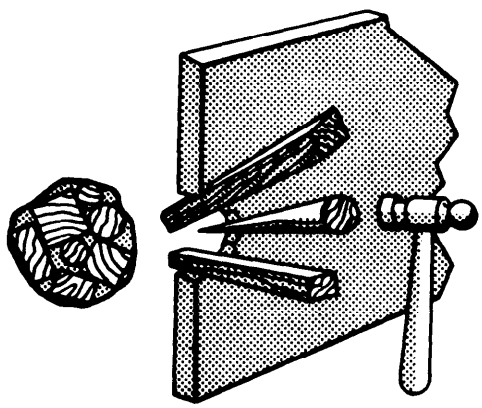

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Figure 7-2.—Combination of plugs used to plug a hole.

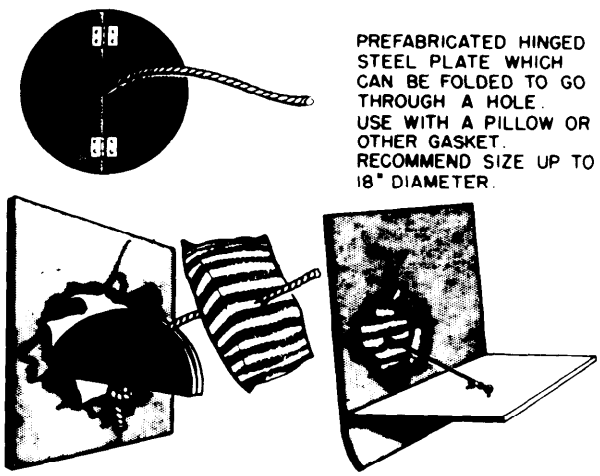

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Figure 7-4.—Application of a hinged plate patch.

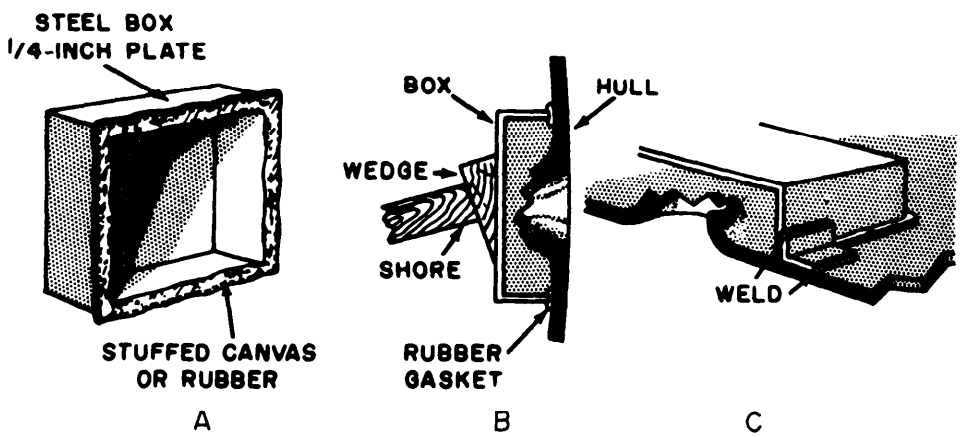

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Figure 7-3.—Application of a box patch.

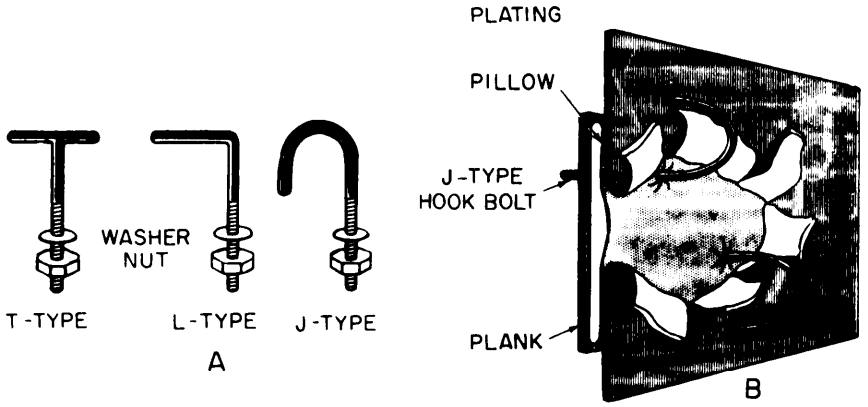

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Figure 7-5.—A. Types of hook bolts. B. Use of hook bolts in applying a patch.

view B shows a metal box patch held in place by shoring; and view C shows a metal box patch welded in place over a hole that has jagged edges.

A hinged patch is designed for use over relatively small holes. This patch has no vertical support to hold it in place. Figure 7-4 shows a hinged plate patch before, during, and after installation.

A hook bolt is a long bolt that is usually fabricated from round steel stock. Hook bolts come in a variety of diameters and shapes. The head is shaped so that the bolt can be hooked to the plating through which the head has been inserted. Figure 7-5 shows T-shaped, L-shaped, and J-shaped hook bolts and how the hook bolts are used to apply a patch. The long shanks are threaded and are provided with nuts and washers. Wood (or sometimes steel) strongbacks are used with hook bolts.

To use a hook bolt, insert the head end of the bolt through the hole in the hull. Rotate or adjust the bolt until it cannot be pulled back through the hole. Slide a pad or gasket that is backed by a plank or strongback over the bolt. Secure the patch by tightening the nut. Generally, these bolts are used in pairs. Hook bolts can be used with a variety of patches and in various combinations.

The folding T-shaped hook bolt has a hinge where the shank joins the crosspiece. This bolt can be folded and inserted through a small hole. When the bolt is pulled back, the crosspiece catches on the hull plating. By using this bolt, a crew member standing inside the ship can put a patch on either the inside or the outside of the ship. By using a retaining line on the bolt, a strongback and a pillow can be threaded over the line and the entire patch folded and placed through the hole. When the line is hauled in, the patch fits against the ship. The patch can be re-adjusted to give a tighter fit. It is also possible to push the pillow and plate over the shank inside the ship to make an inside patch. Nuts and washers are provided to hold and tighten a patch; often large wing nuts are used. Figure 7-6 shows one way in which a folding T-shaped hook bolt can be used to secure a patch.

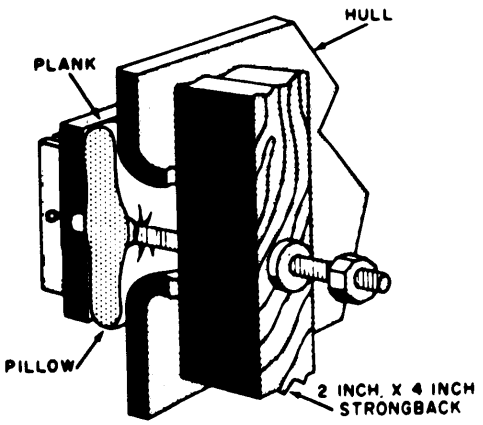

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Figure 7-6.—One method of installing a folding T patch.

Ordinary feather pillows have a tendency to ball up when they are wet and do not provide a uniform surface when used to patch holes. For this reason some ships carry special pillows (fig. 7-7) made of canvas and oakum.

You will frequently find it necessary to improvise patches by using whatever material is handy. This calls for skill and a certain amount of imagination. Hinged or folding prefabricated patches are usually the easiest to use, and in many cases, they are the most effective. But if they are not available, you will need to improvise patches.

CAULKING JOINTS

A riveted joint basically is not watertight or oiltight because the surfaces or edges that are held together are not machined or ground. Therefore, the riveted joints or boundaries tend to loosen from the shock of gunfire, collision, vibration, explosion, and rocking of the ship as a result of high-speed maneuvering. Repairs to this type of damage are usually made by caulking the loosened joint. These repairs must be made as soon as defects are discovered.

In caulking, a thin fin of metal is usually sprung from the baseplate or structure by using a pneumatically driven chisel, caulking tool, or hammer. The general procedure for caulking a riveted joint is illustrated in figure 7-8.

SHORING

Shoring is often used aboard ship to support ruptured decks, to strengthen weakened bulkheads and decks, to buildup temporary decks and bulkheads against the sea, to support hatches and doors, and to provide support for equipment that has broken loose.

Knowing when to shore is a problem that cannot be solved by the application of any one set of rules. Sometimes the need for shoring is obvious. Examples are loose machinery or damaged hatches. However, dangerously weakened supports under guns or machinery may not be so readily noticed. Although shoring is sometimes done when it is not really necessary, the best general rule is this: *If in doubt, shore it.*

SHORING MATERIALS

The basic materials required for shoring are shores, wedges, sholes, and strongbacks. A *shore is* a portable beam. A *wedge is* a block, triangular on the sides and rectangular on the butt end. A *shole* is a flat block that may be placed under the end of a shore to distribute pressure. A *strongback is* a bar or beam of wood or metal which is used to distribute pressure or to serve as an anchor for a patch. The strongback is often shorter than a shore.

Many other items are used in connection with shoring. They include wooden battens, claw hammers, mauls and sledges, handsaws, mattresses, pillows, axes, hatchets, wood clamps, chain falls, electric welding machines, oxyacetylene cutting outfits, cold chisels, wood chisels, nails, wooden plugs, packing sheets, turnbuckles, screw jacks, hydraulic jacks, bolts, nuts, and washers. The COSAL lists the quantity of such gear that each ship should carry on board.

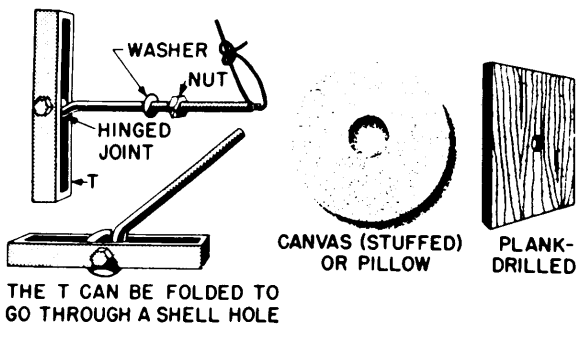

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Figure 7-7.—Materials used in assembling a folding T patch.

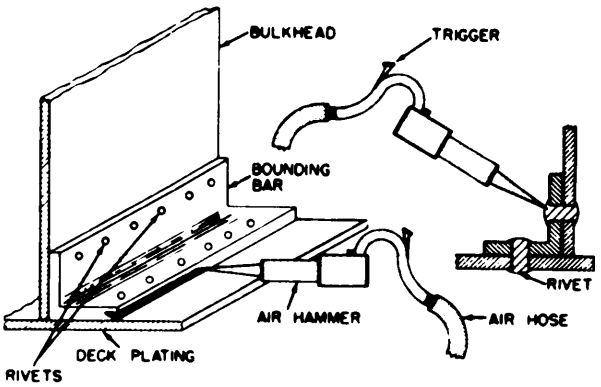

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Figure 7-8.—Cau1king a riveted joint.

Shores

The best woods available for shores are Douglas fir and yellow pine. Hemlock and spruce may also be used. However, they are not as good because they are not as strong. Any wood used for shores should be straight grained and relatively free of knots and cracks. Green timbers are not as strong as cured timbers. If it is necessary to use a poor quality wood, use more shores than would be required for shores of a better quality wood. Shores authorized for shipboard use are treated with a fire-resisting chemical. They should NEVER be painted with an ordinary paint.

The length of a shore in use should never be more than 30 times its minimum thickness. Thus a shore that is 4 by 4 inches should not be any longer than 10 feet. A shore that is 6 by 6 inches should not be any longer than 15 feet. A shore that is 4 by 6 inches should not be longer than 10 feet. The shorter the shore is in relation to its thickness, the greater the weight it will support. Shores should normally be carried aboard ship in 16-foot and 18-foot lengths that can be cut to the required lengths when needed.

Wedges

Wedges should be of softwood, preferably fir or yellow pine. They should be cut with a coarse saw and left rough and unpainted. This allows the wedges to absorb water and hold better than if they are smoothed or painted. A few hardwood wedges should be kept on hand for special uses, since they resist crushing better. However, hardwood wedges cannot be used for all shoring because they have a tendency to work loose. When hardwood wedges are used, they must be checked frequently.

Wedges should be approximately the same width as the shores with which they are used. They may be made with various angles at the leading edge, but a blunt wedge will not hold as well as a sharp one. A wedge should be about six times as long as it is thick. Thus a wedge to be used with a shore that is 4 by 4 inches should be about 4 inches wide, 2 inches thick, and 12 inches long. Figure 7-9 illustrates some wedges and shows how they are used.

Sholes

Sholes should be made of Douglas fir or yellow pine planks that are at least 1 inch thick and 8 to 12 inches wide. Wider sholes can be made

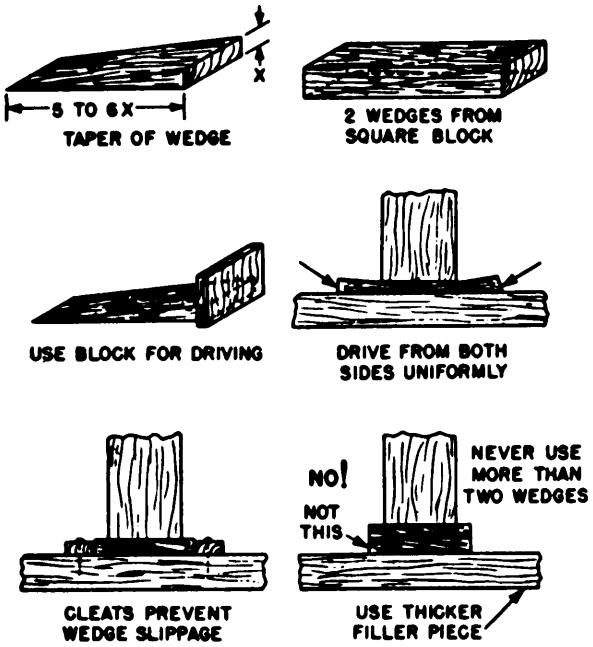

Figure 7-9.—Wedges.

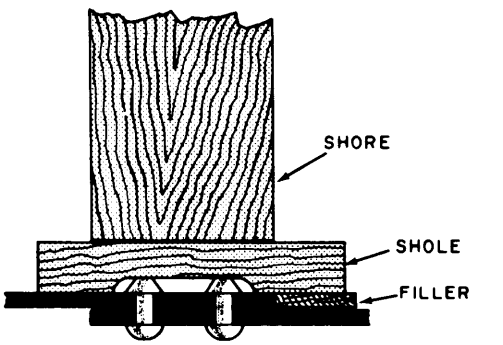

Figure 7-10—Use of a shole.

by nailing cleats across two or more widths of planking. A single plank may have to be cleated at the ends to keep it from splitting. Do not fabricate sholes in advance of the actual need for them; prefabricated sholes would probably not fit where they are needed. The use of a shole is illustrated in figure 7-10.

Strongbacks

All or part of an ordinary shore may be used to make a strongback. Shoring scraps should be

kept for use as strongbacks and short shores. Heavy planks, steel bars, angle irons, and pipe can also be used as strongbacks (fig. 7-6).

Metal Shores

Several types of telescopic steel shores maybe used to make temporary repairs. Not all of these types have proven to be satisfactory for immediate repairs. The metal shores normally will have pins or locking devices and are fitted with a hinged shoe at each end. The pins or locking devices are used to adjust the length of the shore. The hinged shoe may be easily adjusted to any angle and then welded in place. The newer types of metal shores (fig. 7-11) are also fitted with screw jacks or swivel (ball and socket) bases.

The newer steel shores are available in the following models:

- Model 3-5 is adjustable from a minimum of 3 feet, plus or minus 3 inches, to a maximum of 5 feet, plus or minus 3 inches. It will support a maximum vertical load of 20,000 pounds when closed to within 1 inch of the screw jack. It will support a maximum vertical load of 12,000 pounds when fully extended.

- Model 6-11 is adjustable from a minimum of 6 feet, plus or minus 3 inches, to a maximum of 11 feet, plus or minus 3 inches. It will also support a maximum vertical load of 20,000 pounds when closed to within 1 inch of the screw jack. It will support a maximum vertical load of 6,000 pounds when fully extended.

These shores consist of two telescoping, square, steel tubes. Four spring-loaded locking devices, a swivel baseplate, and a screw jack are on the outer tube. A swivel baseplate is on one end of the inner tube. Each side of the shore has a spring-loaded locking device. Each locking device is on the same plane as the locking device on the opposite of it. However, there is a 2 1/4-inch offset of the adjacent locking devices.

The steel shores must be maintained in good operational condition. The tubes must slide easily, and the swivel joints must move freely. The threads of the screw jack must not have any paint on them. Both the swivel joints and the screw jack threads are to be clean and greased. All of the holes and slots are to be open and free of excess paint.

Steel wedges are more valuable for prying things apart than for actual shoring. Steel wedges may be used in conjunction with wooden wedges to take some of the wear and pressure off of the wooden wedges. Steel wedges can also be welded into place when making semipermanent repairs.

Steel sholes are better than wooden sholes for use under the ends of iron pipe that is being used as temporary stanchions. The metal pipe would cut through wooden sholes.

Although steel bars, angle irons, and pipe can be used for strongbacks, their tendency to spring back and forth under variable loads must be considered. These materials can also be used for making semipermanent repairs when time is available.

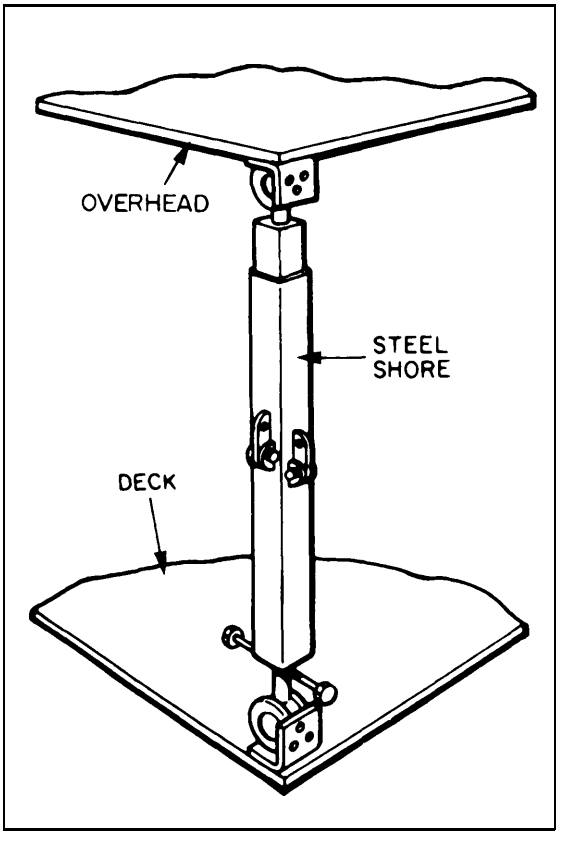

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Figure 7-11.—Steel shore supporting overhead deck or load.

SHORING KIT

Shoring kits are small enough to go through scuttles and other small openings. A shoring kit contains the following items:

- A canvas bag, with a carrying strap, approximately 30 inches deep and 12 inches in diameter

- One 5-pound maul

One 10-pound sledge

One 8-point crosscut handsaw

One 10-foot metal tape rule

One 50-foot metal tape rule

One claw hammer

One hatchet

One 3/4-inch cold chisel

One 1-inch wood chisel

Eight adjustable clamps: four 6 inches and four 8 inches in nominal size

One caulking hand tool

One 24-inch carpenter's square

One electric hand lantern

Eight 2- by 4-inch softwood wedges

One bag of nails; two pounds each of 20d and 30d common nails

- Five pounds of oakum or rags
- Five pounds of sand
- One section of shoring; 4 inches by 4 inches by 10 feet

MEASURING AND CUTTING SHORES

The most rapid and accurate way to measure a shore for cutting is to use an adjustable shoring batten similar to the one shown in figure 7-12. These battens can be made up from items carried aboard ship. Each repair party locker is required to have a shoring batten.

To use the shoring batten, extend it to the required length and lock it with the thumbscrews on the length locking device. Then measure the angles of cut by adjusting the hinged metal pieces at the ends of the batten. Lock the angle locking devices in place. Lay the batten along the shore. Mark and cut the timber to the proper length and angle. Shores should be cut one-half of an inch shorter than the measured length to allow space to install wedges.

If a shoring batten is not available, measure the shores for length by using a folding rule or

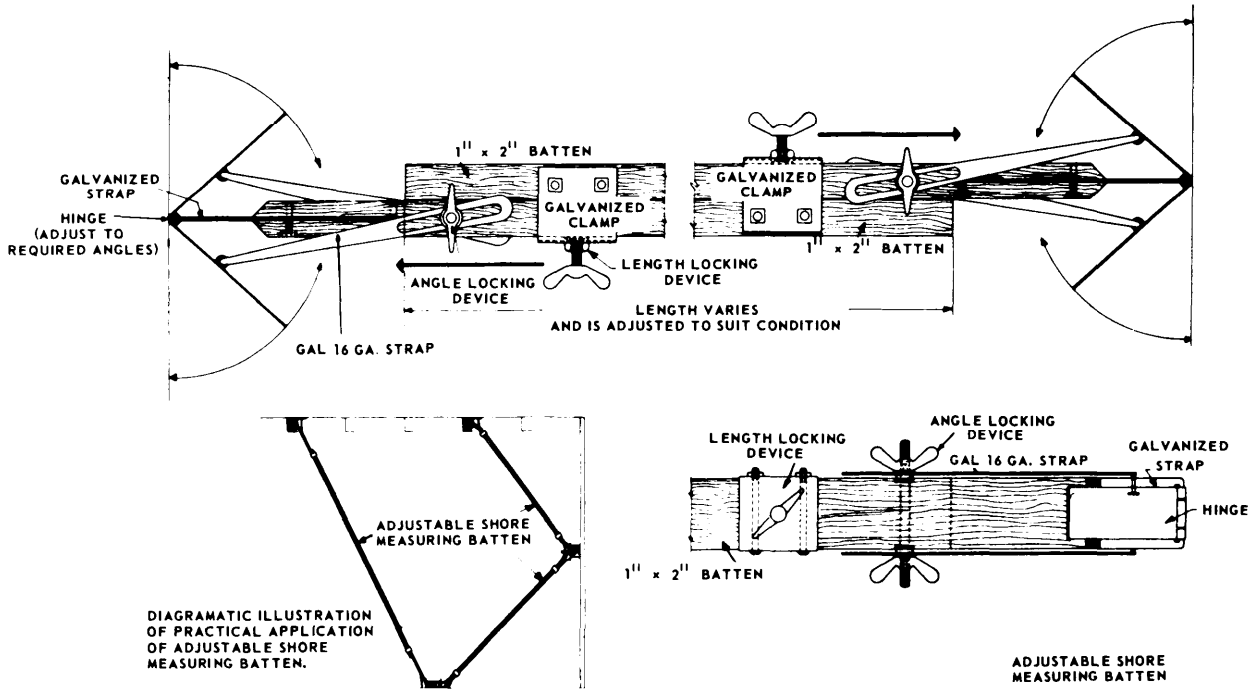

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Figure 7-12.—Shoring batten.

a steel tape and a carpenter's square. The step-by-step procedure for measuring shores in this way, as shown in figure 7-13, is as follows:

1. Measure distance A from the center of the strongback to the deck. This distance is known as the *rise.* Then measure distance B from the edge of the anchorage to the bulkhead. This distance is known as the *uncorrected run.* Subtract the thickness of the strongback from measurement B. This distance is now known as the *corrected run.*

2. Lay off the measurements A and B on a carpenter's square, using the ratio of 1 inch to 1 foot. Rule measurement is taken to the nearest one-sixteenth of an inch. To maintain the 1-inch to 1-foot ratio, use the following conversion table:

ACTUAL RULE MEASUREMENT	MEASUREMENT ON CARPENTER'S SQUARE
3/4 inch	1/16 inch
1 1/2 inches	1/8 inch
2 1/4 inches	3/16 inch
3 inches	1/4 inch
3 3/4 inches	5/16 inch
4 1/2 inches	3/8 inch
5 1/4 inches	7/16 inch
6 inches	1/2 inch
6 3/4 inches	9/16 inch
7 1/2 inches	5/8 inch
8 1/4 inches	11/16 inch
9 inches	3/4 inch
9 3/4 inches	13/16 inch
10 1/2 inches	7/8 inch
11 1/4 inches	15/16 inch
12 inches	1 inch

3. Measure the diagonal distance between A and B. In the example given in figure 7-13, this distance is 7 7/8 inches. Because of the 1-inch to 1-foot ratio, the distance in feet would be 7 7/8 feet or 7 feet 10 1/2 inches.

4. Subtract one-half of an inch, since shores should be cut one-half of an inch shorter than the measured distance to allow for the required wedges. Thus the final length of the shore should be 7 feet 10 inches.

The carpenter's square may also be used to measure the angles of cut and to mark the shore for cutting (fig 7-14). Using the same measurements as in the previous example, proceed as follows:

1. Lay the square along the shore, as shown in part 1 of figure 7-14, making sure that the measurements 4 inches and 6 3/4 inches lie along the same line. Cut the shore to this line.

2. Measure the center of the cut and mark a right angle to it for the second cut. Saw to the line. You have now completed cutting one end of the shore.

3. Along the center of the timber, measure the length of the shore (7 feet 10 inches) and mark off a perpendicular line at the other end of the shore.

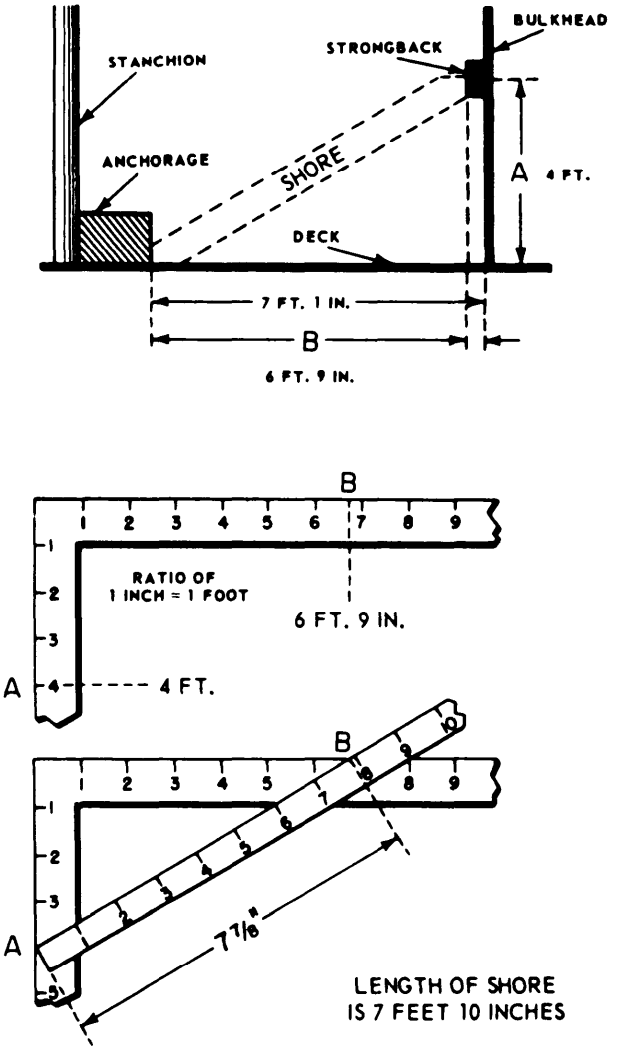

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Figure 7-13.—Measuring length of shore.

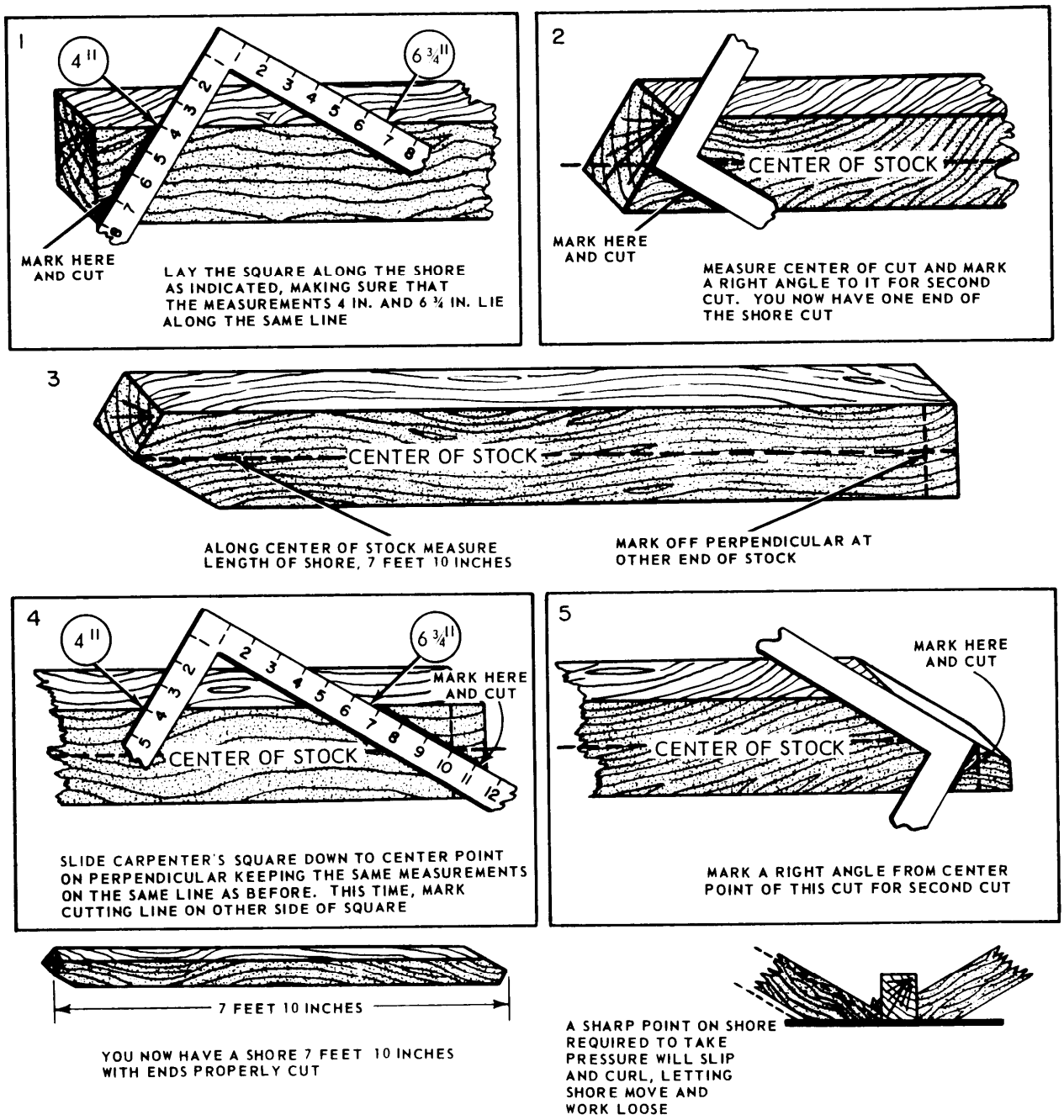

Figure 7-14.—Cutting the angles of a shore.

4. Slide the carpenter's square down to the center point on the perpendicular. Keep the same measurements on the same line as before in step 1. This time, mark the cutting line on the other side of the square.

5. Mark a right angle from the center point of this cut for the second cut. Make your cuts. You now have a shore that is 7 feet 10 inches long with the ends properly cut to fit the measurements.

The proper cutting of shores is an important part of any shoring operation. Shores are usually cut with a hand-held circular saw. However, you

may use an ordinary carpenter's handsaw. All repair party personnel should be instructed in the correct use of these tools. Shores that are poorly cut may cause delay in completing the shoring job and may cause failure of the shoring structure. You will find that the wedges and shores will not fit properly if the shores are not cut correctly. Wet timbers are particularly hard to cut unless the proper methods of sawing are used. In cutting heavy shores, a lumberjack crosscut saw will save a good deal of time. Chisels, axes, and hatchets are also used to cut shores.

TRIMMING SHORES

Shores must be trimmed to fit the shoring structure. The trimming must be done in such a way as to prevent splitting or chipping of the shores. If shore A in figure 7-15 is to fit against a plane surface of shore B and if it must take a load in compression, the end of shore A must be cut square and perpendicular to its long axis.

A sharp point must never be used when a shore will be required to withstand pressure. A pointed end will slip and curl and allow the shore to work loose and move. Figure 7-16 shows correct and incorrect ways to trim shores to present a flat surface at each pressure area.

Shores are sometimes notched at the end to fit against other shores. However, this method should not be used if you expect any great pressure. A safer method is to cut a socket in the side of one shore and fit the butt of the other shore into the socket. This method is illustrated in figure 7-17.

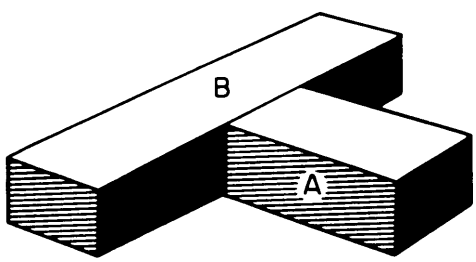

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Figure 7-15.—Trimming shore to shore.

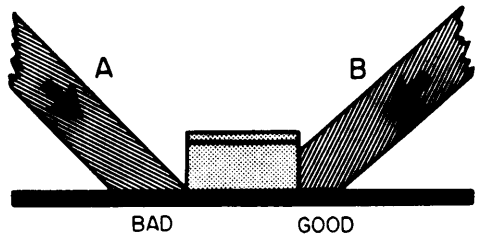

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Figure 7-16.—Trimming shore to deck.

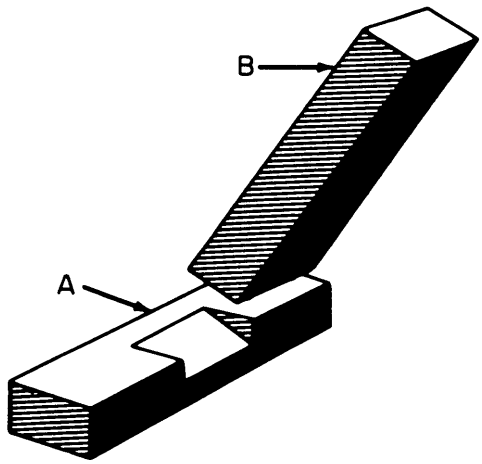

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Figure 7-17.—Socket cut in shore.

GENERAL SHORING RULES

Most shoring is done to support bulkheads that are endangered by structural damage or weakness caused by a hit or by the pressure of flooding water. The pressure on the bulkhead of a flooded compartment is tremendous. Expert shoring is required to hold such bulkheads in place. Some of the general rules to remember in connection with shoring bulkheads are as follows:

- Always allow a large margin of safety. Use MORE shores than you think you need, rather than fewer.

- Spread the pressure. Make full use of strength members by anchoring shores against beams, stringers, frames, stiffeners, stanchions, barbettes, and so forth. Place the legs of the shoring against the strongback at an angle of 45° or 90° if at all possible. Figure 7-18 illustrates the

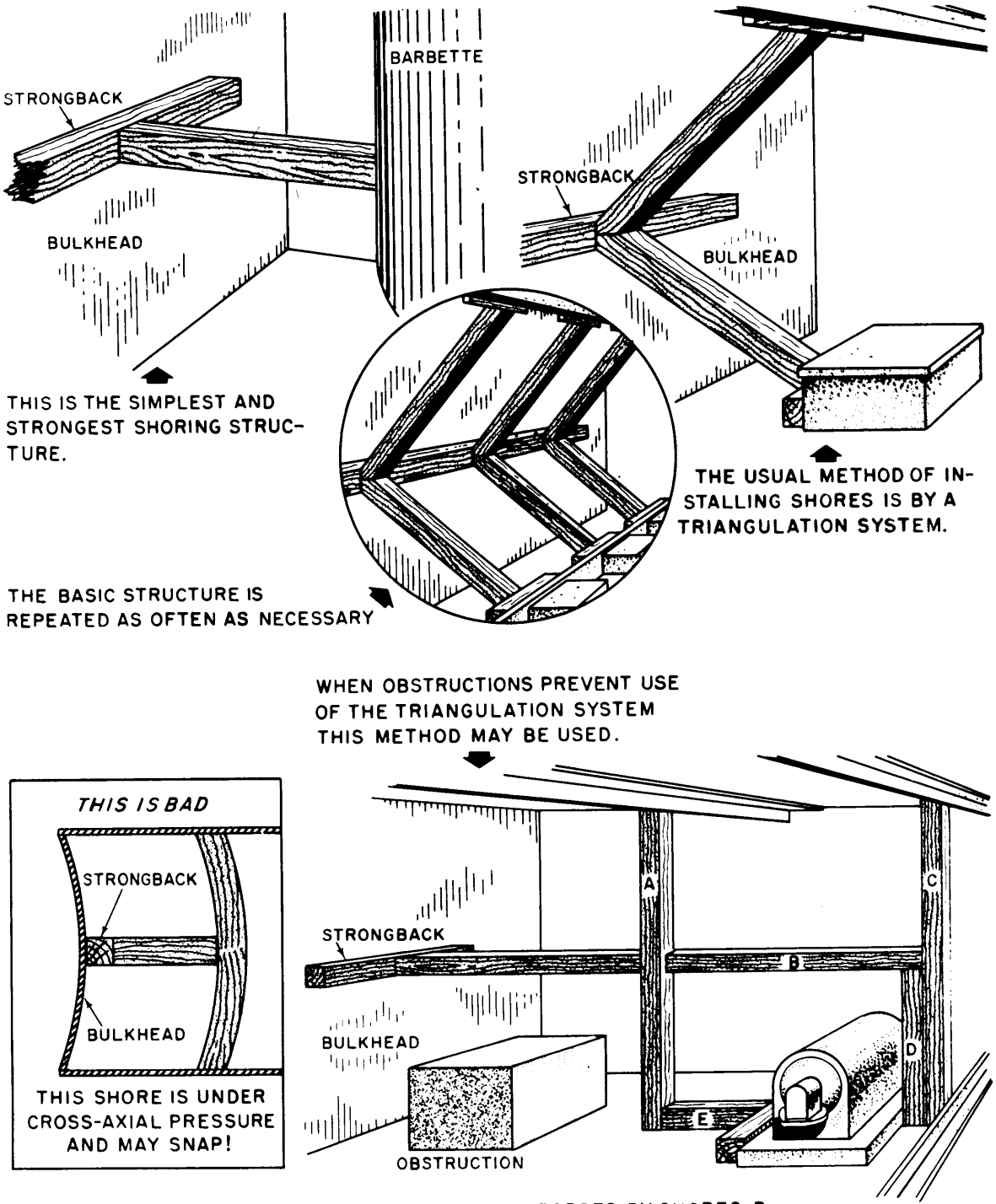

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Figure 7-18.—Shoring against horizontal pressure.

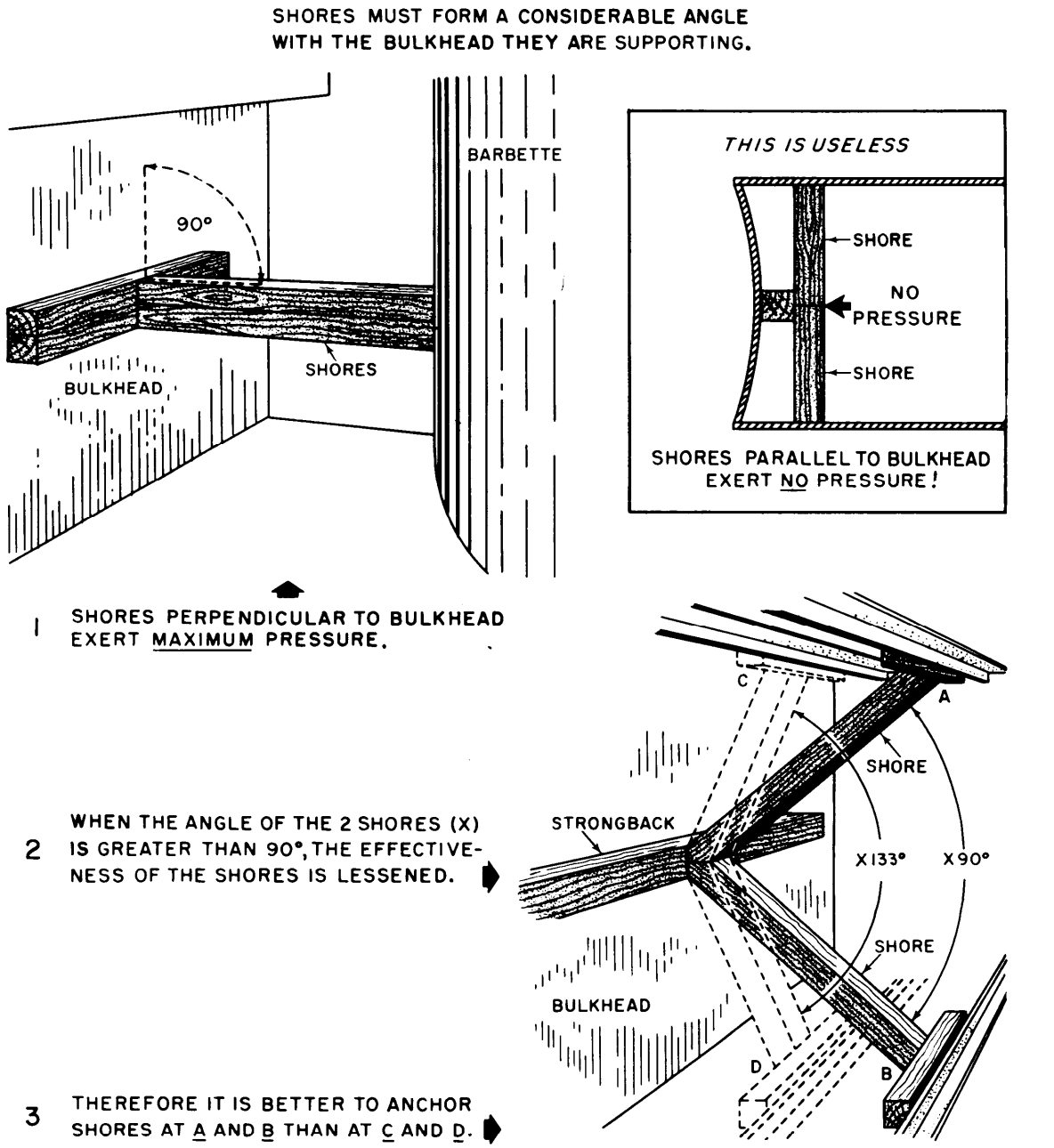

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Figure 7-19.—Shoring angles.

simplest and strongest shoring structure; figure 7-19 shows shoring angles.

● Do not attempt to force a warped, sprung, or bulged bulkhead back into place. Place the shoring so that it will hold the bulkhead in its warped or bulging position.

● When possible, strengthen the main shores with auxiliary shores.

The same general rules apply to shoring a hatch or a door. However, the entire hatch or door should be shored and the pressure should be spread over both the hatch cover or door and the supporting structure, as shown in figure 7-20. Remember that hatches and doors are the weakest part of the bulkhead or deck in which they are installed. Shoring doors and hatches may be complicated by the presence of scuttles and quick-acting handwheels. In this situation, it will be necessary to arrange the shores in such a way as to clear the wheel. A basic rule is to put as many points of pressure on the closure as there are dogs on the closure.

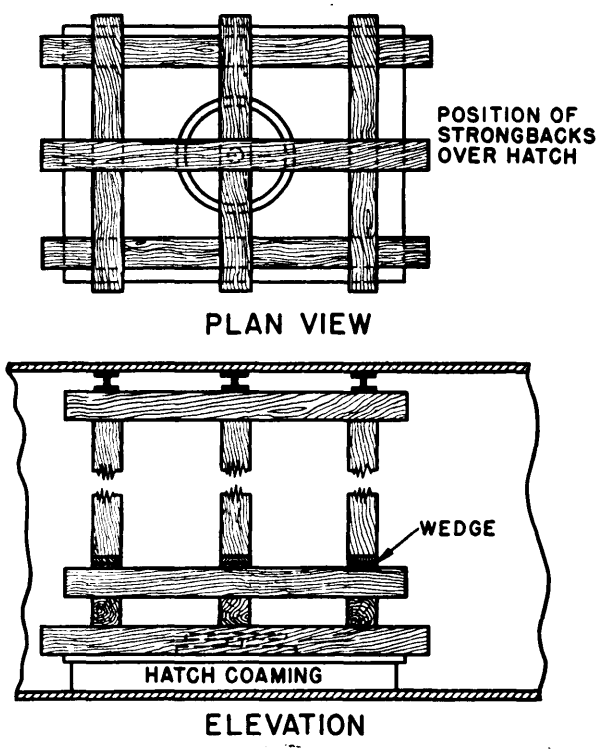

Figure 7-20.—Shoring a hatch.

The success of any shoring job depends largely on the way in which the timbers are wedged. As the shoring job progresses, check carefully to ensure that all of the wedges are exerting about the same amount of pressure on the member being shored. Use as few wedges as possible to obtain satisfactory results. Always drive the wedges in uniformly from both sides so that the shore end will not be forced out of position. Lock the wedges in place so that they will not work loose and cause the shoring to slip. Figure 7-21 shows one method of locking wedges in place.

PRACTICE SHORING

If you are in charge of a shoring detail and if you have enough shores on board, it would be a good idea to give your shoring detail personnel some practice in shoring. As they put up the shoring, explain what they are doing right and what they are doing wrong and, in each case, why it is right or wrong. Ensure that they understand the principles of spreading the pressure, and why a shore in cross-axial pressure might snap. Be sure that they learn how to measure shores and how to cut them correctly before they actually do the cutting.

If possible, obtain permission to put the shoring up in a compartment where it may be left for a few days. This will allow other personnel to inspect it and indirectly learn something about how to shore.

When doing practice shoring jobs, be careful not to cut the shores more than necessary. You will seldom have an oversupply of shores aboard ship. If you do not have spare shores for practice jobs, use strips and battens to build mock-ups and models to scale. Although models are not as effective for training as actual practice shoring jobs, they do have some training effect. One advantage of the models is that you can work out some rather elaborate shoring problems with

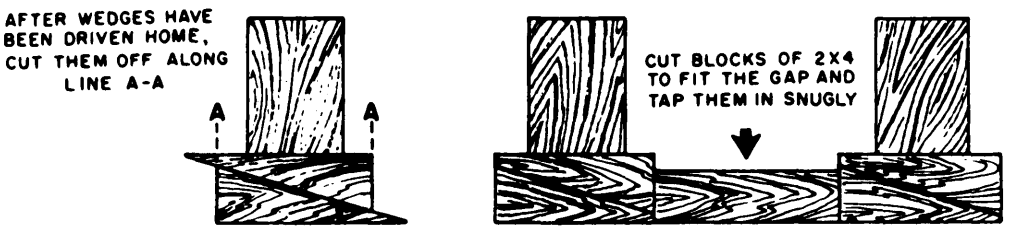

Figure 7-21.—Locking wedges in place.

them. Also, the models can be kept and used again and again for training purposes.

After the shoring practice has been completed (whether using a model or full-size shores), it is a good idea to have the shoring detail personnel discuss the job and make comments on the good and bad points of the shoring. Some of the questions to be brought up in this discussion include the following:

- Is the shoring job effective?
- Could it be made just as effective with fewer shores?
- Should more shores have been used?
- Is the shoring pressure correctly spread?
- Is the wedging done correctly?

This type of questioning and discussion can be effective as a device for making sure that everyone involved really understands the problems and principles of shoring.

EMERGENCY PIPE PATCHING

Damaged piping systems are another source of flooding in compartments. The pipes may have small holes, cracks, or be totally severed. Normally, you will want to isolate the damage by securing the cutout valves on each side of the damaged section of piping. However, whether the piping may be secured, and the amount of time it can be secured, will depend on the service the system provides. A saltwater flushing line may stay secured until repairs can be made after vital repairs have been completed. However, you will need to make temporary repairs on some lines immediately to put the system back into service. Firemain piping, fuel oil lines, and chill water cooling lines to electronic spaces should be repaired as soon as possible.

Small holes in some piping maybe temporarily repaired if you drill the hole out, thread it, and then insert a machine screw. Other holes will require a different means of patching. You may use a jubilee pipe patch, a soft patch, or a metallic pipe patch. The materials for all of these repairs are found in the pipe-patching kit.

Pipe-patching kits are available in the ship's repair lockers. Each kit contains the following items:

- A canvas bag, with a carrying strap, approximately 30 inches deep and 12 inches in diameter
- Several small softwood plugs and wedges; enough to plug 24 inches of split
- Approximately 8 square feet of 1/8-inch rubber gasket
- Approximately 8 square feet of canvas
- One hundred and fifty feet of marlin
- Three pounds of oakum or rags
- One hacksaw with a minimum of six spare blades
- One hatchet or wood chisel
- One hammer, 2 pounds in weight
- A pair of scissors or a knife for cutting the materials
- A banding kit

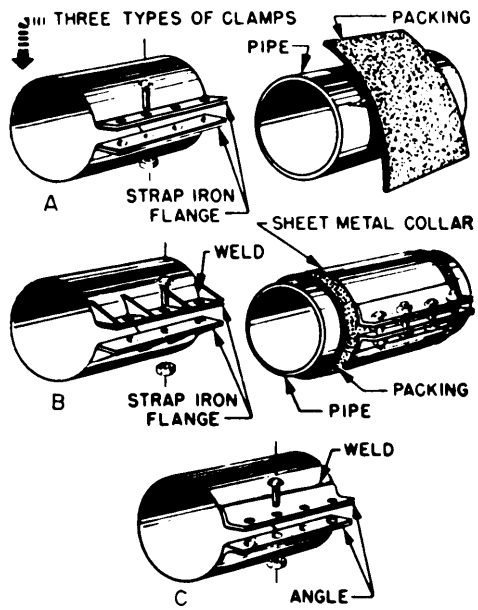

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Figure 7-22.—Jubilee pipe patches.

- A metallic pipe repair kit
- Jubilee pipe patches; a minimum of five in various sizes

JUBILEE PIPE PATCH

The jubilee pipe patch (fig. 7-22) is a modification of a commercial hose clamp. Periodically, you may purchase heavy-duty jubilee pipe patches through the supply system. However, if you cannot purchase them, you can manufacture them yourself.

To manufacture a jubilee pipe patch, roll a piece of sheet metal into a cylinder. Bend a tab on each edge to form a flange. The flanges maybe reinforced by welding on strips of scrap iron. Drill three to five holes through both flanges for the securing bolts. To keep the flange faces somewhat parallel when under pressure, weld small braces from the flanges to the back of the patch.

Use a thick gage sheet metal that will withstand pressure but can also be sprung open enough to be put over the pipe. To use the jubilee pipe patch, put a piece of rubber or gasket material over the hole. It should be large enough to cover and overlap the damage at least 2 inches on all sides. Slip the jubilee pipe patch over the rubber or gasket material. Insert the bolts into the holes and secure them in place. The jubilee pipe patch can withstand 100 pounds of pressure.

SOFT PATCH

Small holes or cracks in low-pressure (150 psi) piping can often be repaired by applying a soft patch (fig. 7-23). When it is possible, reduce the area of the hole first by driving in softwood plugs and wedges as necessary. Do not drive the plugs and wedges in too far or else they will retard the flow of the fluids in the pipe. Once the plugs and wedges are in place, trim them off flush with the outside surface of the pipe. Cover the damaged area with a piece of rubber that will completely cover and extend about 2 inches past the damaged area on all sides. Use two tightly wound layers of marlin or wire to hold the rubber in place.

The soft patch can be modified or improved to suit the conditions at hand. Often it is advisable to use a curved piece of lightweight sheet metal between the rubber and the marline or wire. A coat of red lead on the face of the rubber will also help. You can also use marlin and oakum as a caulking material in the cracks. The soft patch

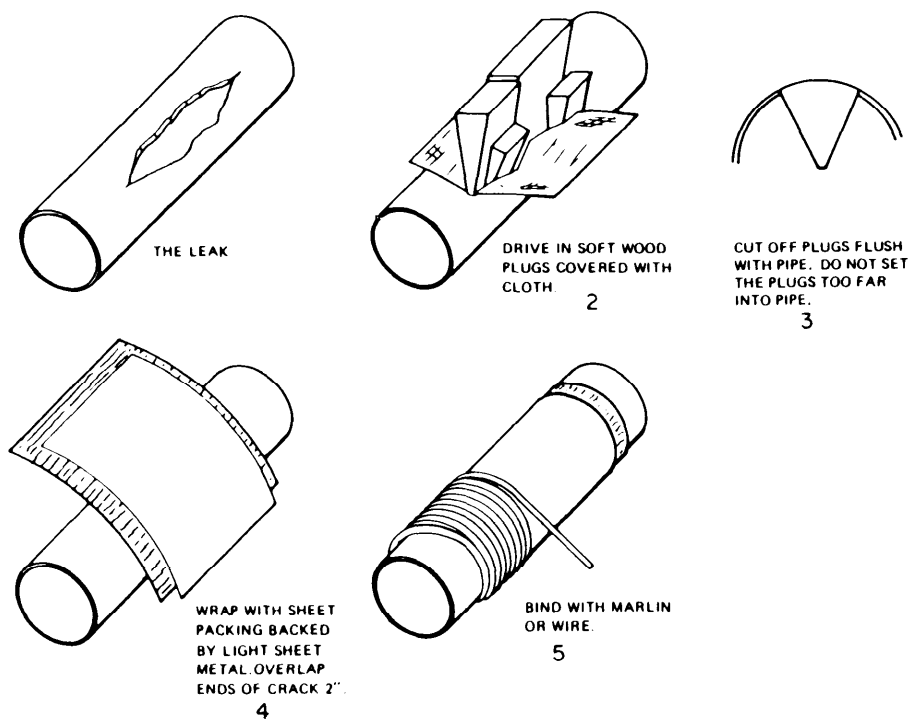

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Figure 7-23.—Soft patch on a low-pressure pipe line.

can withstand 150 psi. For some types of damage, such as sharp bends in the piping, a soft patch will not be effective. In such cases, you would use a metallic pipe patch instead of the soft patch or jubilee pipe patch.

METALLIC PIPE PATCH

The metallic pipe and general-purpose damage control kit is used to make metallic pipe patches, also referred to as a plastic patch. The kit is part of the required repair locker equipment inventory and contains the materials needed to repair various piping-system lines. Most of these repairs can be made and the system restored to service within 60 minutes.

Kit Contents

The complete kit contains the materials listed below. These materials may be ordered individually whenever a need arises to replace them in the kit.

Assembly I

- Four cans liquid resin, 400 grams each
- Four cans liquid hardener, 100 grams each
- One piece woven roving cloth, 24 by 40 inches
- One piece void cover, 8 by 36 inches
- One piece polyvinyl chloride (PVC) film, 48 by 60 inches
- One chalk line, one-eighth of a pound
- Four pairs of gloves
- Two eyeshields
- Four wooden spatulas
- One sheet of abrasive cloth, 9 by 11 inches
- One pair of scissors
- One instruction manual

Assembly II

- Four cans paste resin, 300 grams each
- Four cans paste hardener, 75 grams each
- Four tongue depressors

Before you can have a good understanding of the kit and its uses, you will need to know more about plastics in general. The following paragraphs will give you the basics on the materials in the kit.

RESINS AND HARDENERS.— The liquid and paste resins are of the epoxy type. The liquid and paste hardeners are chemical compounds used to harden the resins. These resins and hardeners are packaged in premeasured amounts. For proper mixture and better results, mix all of the hardener in the smaller can with all of the resin in the larger can.

CAUTION: DO NOT MIX HARDENER WITH RESIN UNTIL ALL PREPARATIONS HAVE BEEN COMPLETED. DO NOT INTERMIX LIQUID RESIN AND PASTE HARDENER OR PASTE RESIN AND LIQUID HARDENER.

When the resins and the hardeners are mixed together, a chemical reaction begins. This reaction is exothermic, which means that heat is given off. For approximately 12 to 17 minutes, the temperature increases gradually until it reaches 120°F to 135°F. At this temperature a sudden, sharp increase in the temperature occurs until it reaches its peak at about 350°F. This sudden, sharp rise in temperature is known as *kick-over.* At this peak temperature, the resin-hardener mixture begins to solidify and change color from gray to light brown.

The mixture cools slowly because of the poor thermal conductivity of the materials. After kick-over, the mixture continues to harden and increase in strength. This process is known as *curing.* Approximately 30 minutes after kick-over, the patch is strong, hard, and cool enough to use. Do not restore pressure to the system until the patch has cured or when you can place your bare hand on it without discomfort from heat.

Several factors contribute to the control of kick-over. The most important is temperature. Both the initial temperature of the activated resin mixture and the temperature of the atmosphere affect the kick-over time. The initial temperature has the greater effect. When the temperature of the resin and the hardener before mixing is increased, the kick-over time decreases. Also, when

those temperatures are decreased the kick-over time increases.

You should be able to predict the time of kick-over. The kick-over time can decontrolled only within certain limits. Therefore, the patch needs to be completely applied before kick-over occurs.

Figure7-24 shows the relationship of kick-over time to the resin temperature. If you know the resin temperature at the time of mixing, you can determine the amount of time available to apply the patch before kick-over occurs. Look at point *A* in figure 7-24 where the resin temperature is 800. The kick-over will occur in less time than if the resin temperature was 600 (point 13). The difference in resin temperatures means that you have 9 minutes versus 18 minutes to apply your patch.

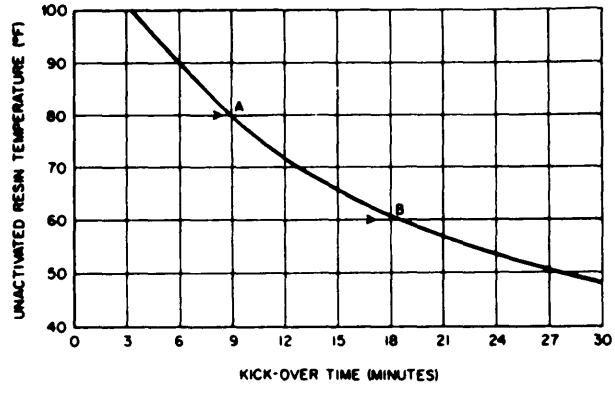

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Figure 7-24.—Resin temperature vs. the kick-over time.

NOTE: If the initial resin temperature exceeds 80°F, the temperature before mixing should be reduced by artificial means to 73°F. This allows for additional working time.

VOID COVERS.— The void cover is a resin-treated glass cloth that can be cut and formed to cover the damaged area and is rigid enough to give support to the patch.

WOVEN ROVING CLOTH.— The woven roving cloth is made of a short staple glass fiber woven into a thick, fluffy cloth. This cloth will be coated with the resin-hardener mixture and either wrapped around or placed over the damaged area. The glass cloth provides the main strength of the patch and a means of applying the resin-hardener mixture.

FILM (PVC).— The plastic film is a thin, transparent polyvinyl chloride material (PVC). It is used as a separating film for the flat patch. Its purpose is to prevent the patch from sticking to the backup plate or other supports. In the pipe patch, it is used to cover the entire patch and keep the activated resin around the patch. Kraft wrapping paper may be used as a substitute if necessary.

Advantages of the Plastic Patch

From the damage control viewpoint, the main advantages of a plastic patch are versatility, simplicity, effectiveness, speed of application, and durability.

The plastic patch can be used on a variety of damaged surfaces with smooth or jagged protruding edges. The plastic has excellent adhesive qualities. It can be readily applied to steel, cast iron, copper, copper-nickel, brass, bronze, and galvanized metals.

It is relatively easy to apply a plastic patch. Inexperienced people can do it. If they follow instructions carefully, the patch will be 100-percent effective. If the patch leaks, then it is likely that proper preparation and applications procedures were not followed.

The speed of application will vary somewhat with the size and the type of rupture and also with local working conditions. A simple patch can be applied to a 4-inch pipe in 10 minutes or less by an inexperienced crew with the minimum amount of training and indoctrination. The type and the size of the rupture, or the shape and the size of the structure to which the patch is applied, have little effect on the time involved in patching. However, some types of damage may require more initial preparation.

There is no known time limit on the life of a plastic patch. It will certainly last until permanent repairs can be made. The patch is relatively inert, being seriously affected only by excessive heat and concentrated acids.

Application of Plastic Patches

The following discussion will help you apply different types of plastic patches (simple, elbow, severed, and others). You will see that as the individual patch materials are applied, the patch

becomes progressively wider. Figure 7-25 illustrates the positions of the patch materials in relation to one another. You must consider the buildup in the length of the patch when you plan the application. When possible, allow the patch to extend at least 4 to 5 inches on either side of the rupture.

In addition to the size of the rupture, the width of the patch may also depend upon the location of the rupture in the pipe system. For example, an elbow rupture may require a patch of greater width than would the same size rupture in a straight section of pipe.

You must make the following preparations before you apply the plastic patch:

1. Secure or isolate the ruptured area in the piping system.
2. Remove all lagging.
3. Clean the area around the rupture and remove all grease, oil, dirt, paint, and other foreign matter. If grease or oil is present, use an approved solvent, such as methyl chloroform. If an approved solvent is not available, scrape and wipe the surface until it is clean. The surface may then be further abraded for better adhesion. An abrasive cloth is furnished with the kit.
4. Make sure that the entire pipe surface is dry.
5. Where practical, simplify the rupture by bending or removing irregular projections. This may be done by cutting or burning.

CAUTION: IT IS OF THE UTMOST IMPORTANCE THAT NO EXPLOSIVE CONDITIONS EXIST BEFORE USING SPARK-PRODUCING TOOLS OR BURNING EQUIPMENT.

6. Determine the amount of materials you will need. For example, a 2-inch rupture in a 2-inch-diameter pipe will require 500 grams of activated resin and a length of woven roving cloth that is at least 25 inches long. Cut the woven roving cloth, in width, to extend at least 3 to 4 inches on either side of the rupture.

SIMPLE PIPE PATCH.— Use these step-by-step procedures to apply the simple pipe patch.

1. Put on the eyeshields and the gloves. Then open the liquid resin can and the liquid hardener can.

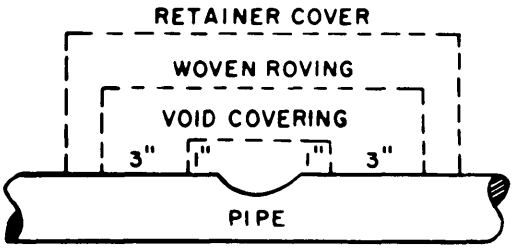

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Figure 7-25.—Relative positions of patch materials.

2. Add the hardener to the resin and mix thoroughly for approximately 2 minutes or until it is a uniform gray color. (Note that all of the liquid hardener in the smaller can is the correct proportion to mix with all of the liquid resin in the larger can.)

3. Coat both sides of the void cover with the resin-hardener mixture. Tie the void cover over the rupture with a chalk line (view A of fig. 7-26.).

4. Lay the woven roving cloth on a clean, flat surface. Starting at one end of the cloth, pour on the resin-hardener mixture and spread it evenly over the entire surface of the cloth using the spatula provided in the kit. It is only necessary to impregnate one side of the woven roving cloth. However, you must ensure that the edges are well impregnated with the resin-hardener mixture.

5. Center the woven roving cloth over the void cover with the impregnated side toward the pipe. Wrap the cloth around the pipe not less than three turns and preferably not more than four turns. (See view B of fig. 7-26.)

6. Wrap the PVC film at least two complete turns around the entire patch. Tie the PVC film with the chalk line, starting from the center of the patch and working toward one end, making 1/2-inch spacings between spirals (view C of fig. 7-26). Tie this end securely, but do not sever the line. Make one spiral back to the center of the patch. Then working to the opposite end from the center of the patch, make 1/2-inch spacings between spirals and again secure the line. After 30 to 40 minutes the patch should be sufficiently cured to restore the pipe to service.

Remember, for best results the temperature of the liquid resin and the liquid hardener before

mixing should be approximately 70°F. With a temperature of 70°F at the time of mixing, the patch will cure approximately 1 hour from the initial mixing time. After this hour, pressure may be restored to the piping system. In emergencies, if the temperature of the resins and hardeners is below 50°F, you can accelerate kick-over by applying external heat with hot-air heaters. However, the heat must be applied gradually. Too much heat will cause the plastic patch to be extremely porous and fail.

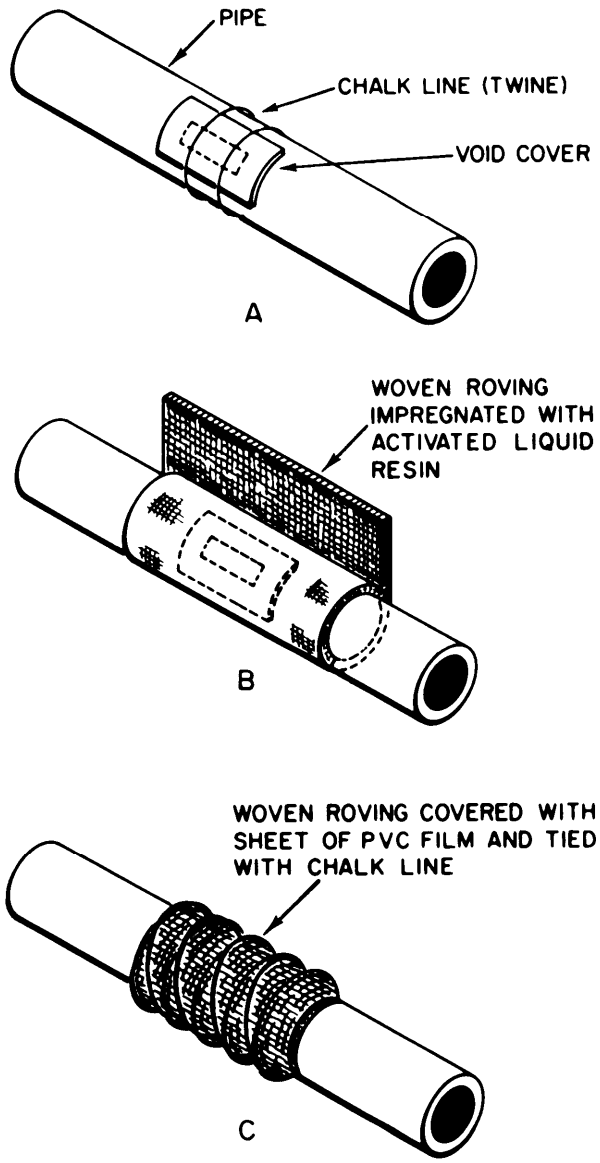

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Figure 7-26.—Simple pipe patch.

ELBOW PATCH.— The elbow patch shown in figure 7-27 is applied using the same basic procedures as the simple patch but with the following exceptions:

1. Slit the edges of the void cover 2 to 3 inches at each end to conform to the contour of the pipe. (See view B of fig. 7-27.)

2. After the impregnated woven roving cloth has been wrapped around the pipe, use your gloved hand to shape the cloth to the contour of the pipe. (See view C of fig. 7-27.)

3. Apply the PVC film and tie it with the chalk line as described for the simple pipe patch. (See view D of fig. 7-27.)

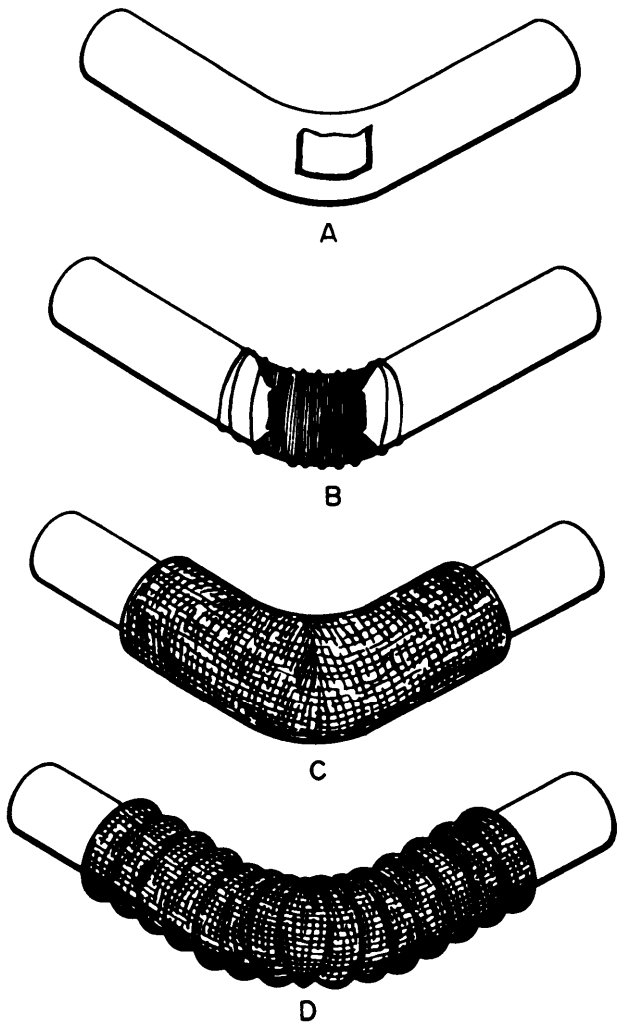

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Figure 7-27.—Elbow pipe patch.

SEVERED PIPE PATCH.— The severed pipe patch shown in figure 7-28 is also applied with the same basic procedures as the simple pipe patch. But this procedure also has some exceptions:

1. Where the gap exceeds 4 inches, thin sheet metal or other suitable materials may be used as a substitute for the void cover in bridging the gap. The substitute material should be cut so that it will extend at least 2 inches on either side of the gap. It should be long enough to provide one complete turn around the pipe with a possible overlap of about 2 inches. Secure the substitute material with the chalk line.

2. Cut the woven roving cloth so it will extend at least 4 inches beyond the edges of the bridge material. Impregnate the cloth with the resin-hardener mixture. Wrap the cloth around the bridge materials and tie it securely as you did for the simple pipe patch.

3. Apply the PVC film and tie it securely with the chalk line as you did for the simple pipe patch.

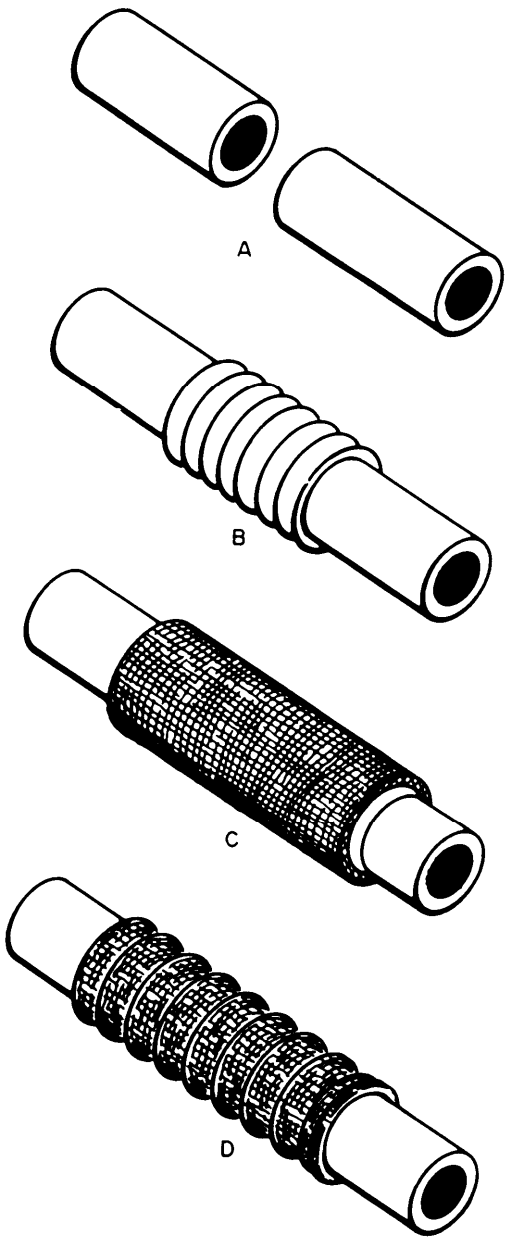

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Figure 7-28.—Severed pipe patch.

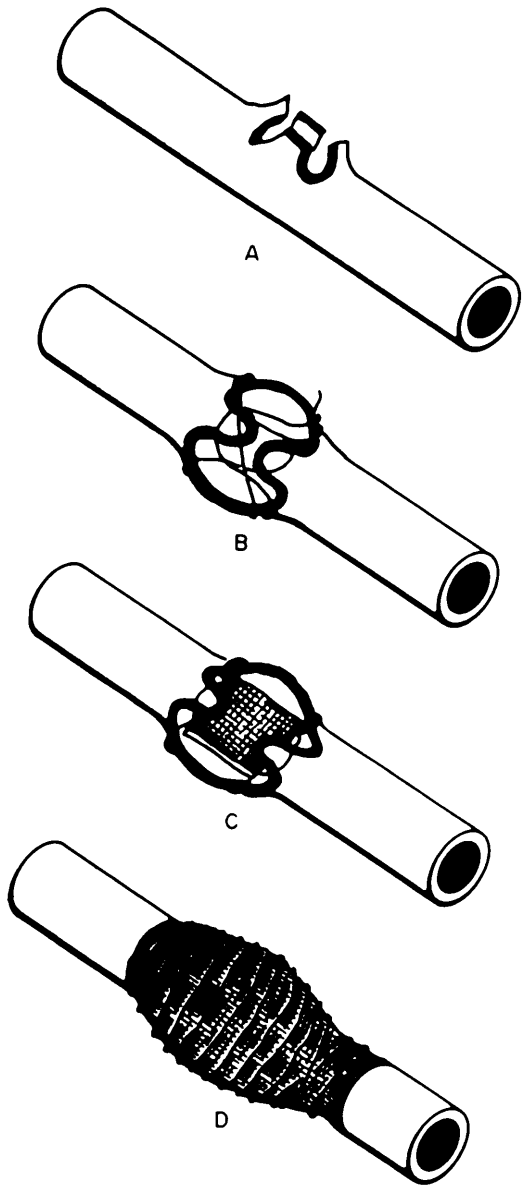

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Figure 7-29.—Compound rupture patch, edges not removed.

COMPOUND PATCH.— When repairing battle damage to piping systems, you will often work on a compound rupture, as shown in view A of figure 7-29. Compound ruptures may take a variety of shapes. Therefore, it is more difficult to select a single example to fit all repairs. In most compound ruptures, it should be possible to simplify the rupture by removing butterfly edges. You may also cut away the damaged section to form either a severed pipe or a simple pipe repair. Sometimes you cannot remove the butterfly edges or other projections by pounding them in or by cutting or burning them off. In that case, you can apply a simple pipe patch with the following modifications:

1. Tie the chalk line firmly between the jagged edges (view B of fig. 7-29), crisscrossing as much as possible. This chalk line acts as a support for the woven roving cloth and keeps it from falling into the void. No void cover is used in this example. It would be impractical to cut a void cover to suit the jagged edges.
2. Fold a small piece of impregnated woven roving cloth (view C of fig. 7-29); lay it in the void where it helps to build up the mass and acts as an insulator.
3. Apply the precut woven cloth (view D of fig. 7-29) over the small folded piece of woven cloth. Tie it firmly in place as outlined previously for the simple pipe patch.

FLANGE PATCH.— The flange patch is applied to a damaged flange (view A of fig. 7-30). The application is similar to that used for a single patch with the following modifications:

1. Cut the void cover into an H shape (view B of fig. 7-30), impregnate it with the resin-hardener mixture, insert it into the void, and tie it securely in place.
2. Cut your pieces of woven roving cloth, each of them long enough to make one complete turn around the pipe and overlap 1 inch. Cut these four pieces in an H shape, but do not cut away the center pieces. Instead, fold them up over the edges of the flange.
3. Impregnate the separate plies of woven roving cloth and place them over the rupture (view c of fig. 7-30).
4. Apply the PVC film and tie it down firmly, starting at one end working up to the flange. Make several windings of the chalk line through the gap in the flange in a figure X to have the woven roving cloth conform to the center of the rupture and the flange edges. Continue on to the opposite end of the patch and tie securely in place.

Repair Kit Review

An ideal plastic patch is one which can be applied and cured in the shortest time possible and will maintain the desired tightness. The primary factor controlling the kick-over time is the

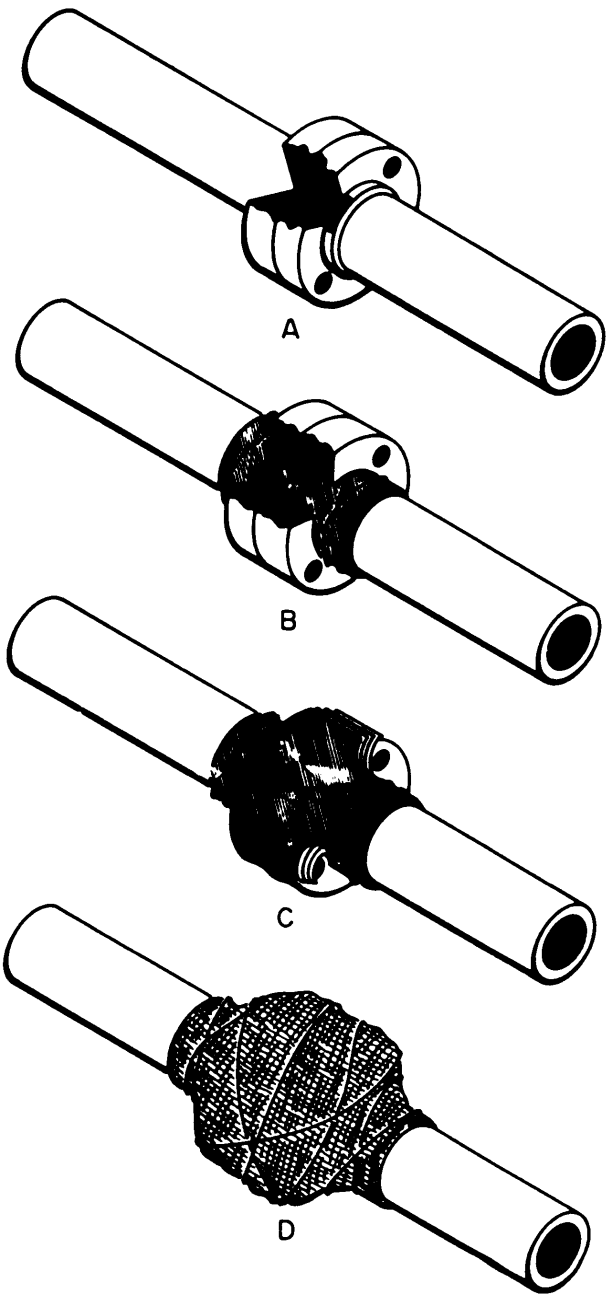

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Figure 7-30.—Flange rupture patch.

temperature of the resin and hardener before mixing. For the patch to cure in the shortest time possible, you must contain the heat generated in the patch. You do this by creating a mass about the break in the pipe or bulkhead rupture by using an impregnated woven roving cloth. You can see, therefore, that the correct amount of mass is necessary to have an effective patch. It is also important that the patch cools readily; you cannot restore pressure to the system until the patch cools to about 150°F. The net result is that you build up a mass about the rupture that will give you a patch with the most desirable characteristics in the shortest possible time. The plastic pipe patch can withstand 300 psi at 200°F.

CASUALTY POWER SYSTEMS

The casualty power system is one of the most important shipboard damage control systems. The system is a simple electrical distribution system. It is used to maintain a source of electrical power for the most vital machinery and equipment needed to keep the ship afloat or to get the ship out of a danger area. The casualty power system is intended to provide power during real emergencies only. It must NOT be used as a means of making temporary routine repairs.

A casualty power system consists of the following items:

- Portable cables stowed in racks throughout the ship
- Bulkhead terminals for carrying the circuit through bulkheads without breaking the watertight integrity of the ship
- Risers between decks
- Casualty power connections at the source of supply

Figure 7-31 illustrates a casualty power run.

Portable casualty power cables are equipped with metal tags that indicate the length of the cable and the location of the cable stowage rack (fig. 7-32). Portable casualty power cables should be rigged only when required for use or when required for practice in rigging the casualty power system. At all other times, the cables should be stowed in the cable rack indicated on the cable tag.

When casualty power cables are rigged, the connections must always be made from the load

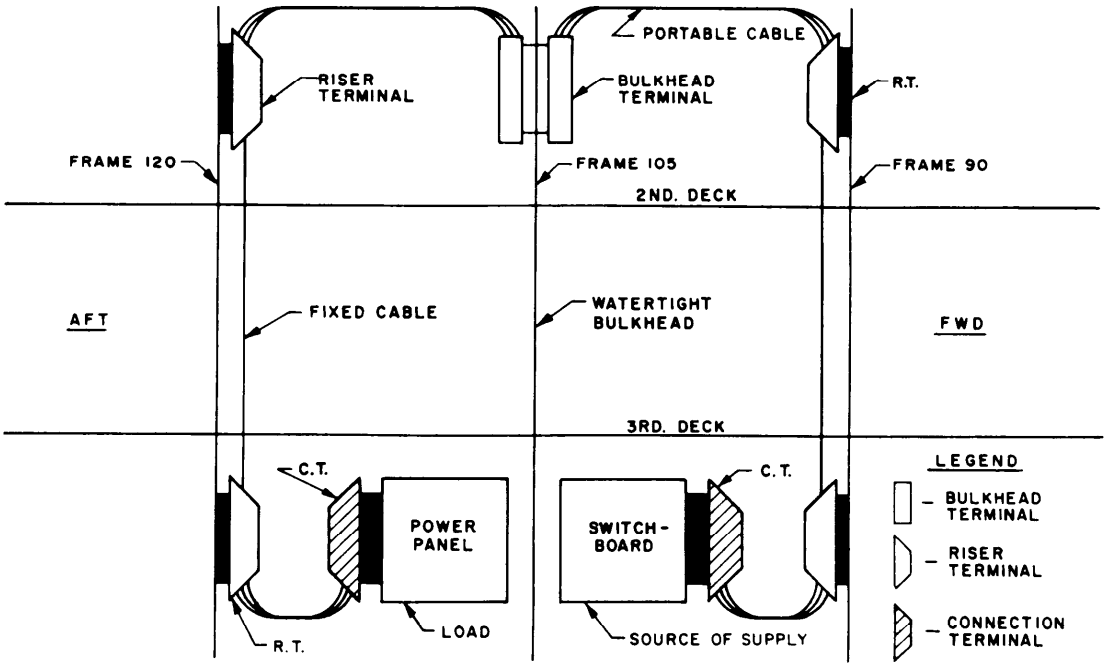

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Figure 7-31.—Casualty power run.

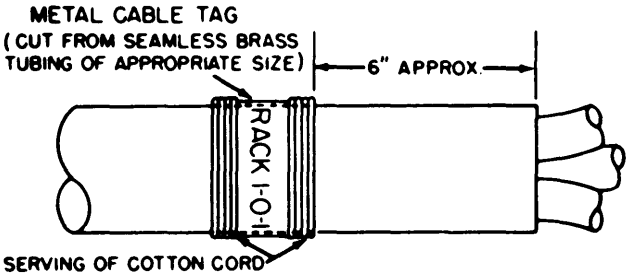

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Figure 7-32.—Portable casualty power cable tag.

to the supply to avoid handling energized cables. Portable signs saying DANGER—HIGH VOLTAGE must be posted at each connection and at 10-foot intervals along the length of the cable. The cables must be secured to the overhead, clear of the deck.

Sources of supply for casualty power use are provided at each ship's service and emergency switchboard. These consist of casualty power connection terminals on each switchboard; the terminals are connected to the bus bars through circuit breakers. Some ships also have small diesel-driven generators designated for casualty power use only. These generators are quite small and have very little control equipment.

Casualty power connection terminals are installed in power panels that feed equipment designed to receive casualty power. The casualty power connection terminals on the power panels may also be used as a source of supply to the casualty power system.

Remember that all terminals on power panels are *hot*. The normal supply to a panel must be shut off before the casualty power cable is connected to the terminals.

Machinery that can be supplied by the casualty power system includes steering gear, IC switchboards, fire pumps, and vital auxiliaries in firerooms and engine rooms.

An alternating current (a.c.) casualty power system consists of the following equipment and fixtures:

● Racks containing various lengths of portable thermoplastic-covered or neoprene-covered cable. Each cable contains three leads or conductors (fig. 7-33). One lead is colored black, one is white, and one is red. This same color code is used in all three-wire power circuits throughout the electrical installations aboard ship.

● On small ships, bulkhead terminals provide for a single horizontal run of portable cable along the main deck, inside the superstructure. On large ships, there are generally terminals for two horizontal runs, one port and one starboard. These runs are located on the second deck. The terminals extend through the bulkhead and project from it on both sides. They do not impair the watertight integrity of the ship. The cable ends are inserted around the outer rim (or curved surface) of the terminal into the holes provided. There are three groups of three holes each. The

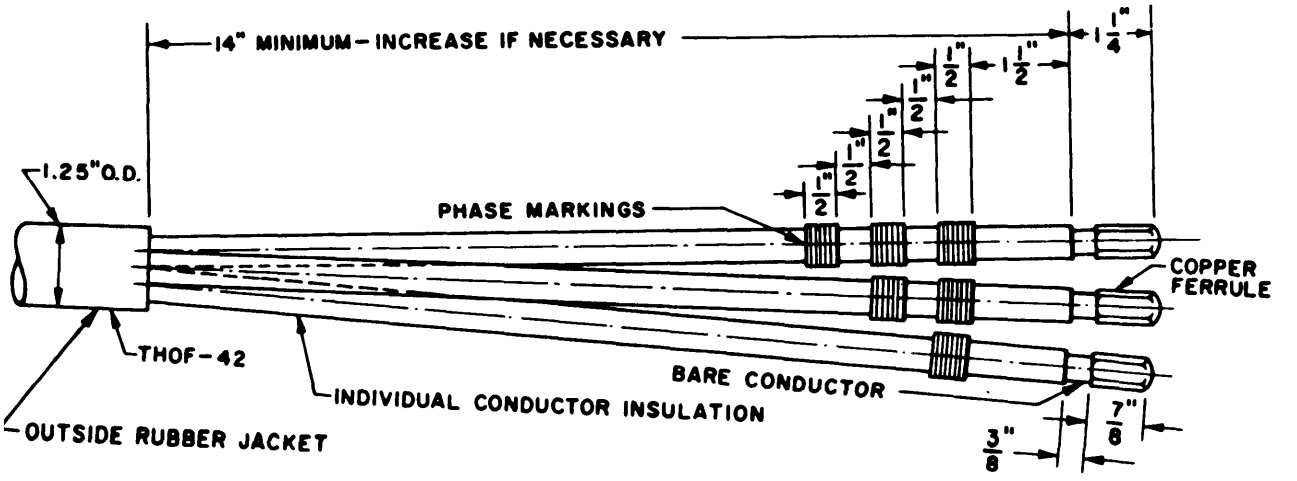

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Figure 7-33.—Portable casualty power, 450 volts, three-phase cable end.

face of the terminal also contains three groups of three holes each. The square-shanked insulated wrenches fit into these holes and are used to secure the cable in the terminal. Two of these wrenches are provided in a rack mounted on the bulkhead at each point where they are required. They must be kept in the rack at all times except when they are actually in use.

● Riser terminals are similar to bulkhead terminals. However, they are connected to other riser terminals by permanently installed armored cable to provide vertical runs. These riser terminals carry the casualty power from the generators to the main and the second deck levels.

● Portable switches are sometimes mounted on bulkheads near the cable racks. These are simply ON-OFF switches that are equipped with special holes for use with the portable cables.

The faces of the casualty power terminals of an a.c. system are marked A, B, and C, and the ends of the cables are colored black, white, and red, respectively. When connecting the cables to the terminals, connect the black lead to A, the white lead to B, and the red lead to C.

The color code is not sufficient for making proper connections in the dark or under other adverse conditions. Therefore, it is necessary to provide some means to identify each lead and its proper hole in the terminal by touch. This is accomplished by molded knobs in the A, B, and C portions of the terminals. There are one, two, or three knobs, respectively, in the A, B, and C portions of the terminals. Similarly, a piece of heavy twine is placed on the black lead of the portable cables, two pieces are placed on the white lead, and three pieces are placed on the red lead. Each of these servings of twine is about one-half of an inch wide. (A new method of phase identification is similar to the old method, except that O rings and heat shrinkable tubing have been substituted for the cotton cord servings, as shown in figure 7-34.) Each lead and its corresponding position in the terminal can be identified by merely feeling the leads and matching the number of

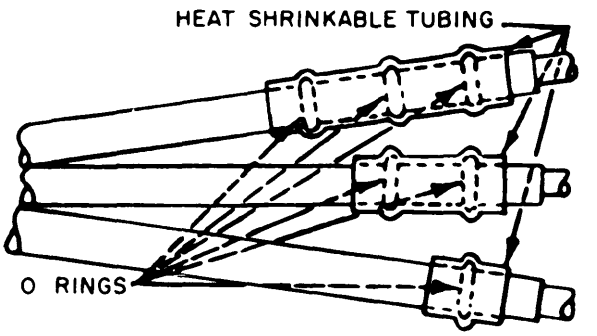

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Figure 7-34.—New method of cable identification.

pieces of twine on each lead with the same number of raised knobs in the proper area of the terminal. In older ships, the casualty power fittings have identifying V-shaped notches in the outer edge of the fittings instead of the knobs.

When connecting a casualty power cable run, remember that you must ALWAYS connect from the load to the source of supply. This is to avoid working with live cables.

SUMMARY

When battle damage occurs, it must be repaired. In most cases, you will make a temporary repair until a permanent repair can be made. Shoring, plugging, and patching are your normal means of making the necessary temporary repairs. When the power source for certain vital equipment is discontinued, you will be required to supply power to the equipment by an alternate means, known as the casualty power system.

Review the information presented to you in this chapter until you are familiar with it. If it is possible, put the information into practical use with training aids such as a section of pipe that may be connected to a ship's fireplug. Do not use expendable materials for training purposes until you have received permission from your work center supervisor or the damage control assistant (DCA).